

BC Generation Overview

Central Asia Delegation

30 January 2013

Doug Robinson
Canadian Entity Secretary
BC Hydro - Generation



Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.

System Reservoirs



Williston (Peace River):

- **18,600 GWh Water License storage (historic min at 5,700 GWh)**
- **Top foot: 270 GWh of energy**



Kinbasket (Columbia River):

- **10,400 GWh Water License storage (historic min at 700 GWh)**
- **Top foot: 100 GWh of energy**

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Generation Resources - Peace



- **3500 MW capacity (4400 MW with Site-C)**
- **17 000 GWh average energy (22 000 GWh with Site-C)**
- **Multi-year storage**
- **Constrained by downstream winter ice restrictions**
- **Provides approximately 30% of BC Hydro's energy resources**

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Generation Resources - Mainstem Columbia



- **Kinbasket Reservoir, Mica and Revelstoke GS, Arrow Lakes Reservoir**
- **4300 MW capacity**
- **Net 15,500 GWh average energy**
- **Multi-year storage**
- **Constrained by rules of Columbia River Treaty and Non-Treaty Storage Agr.**
- **Provides about 27% of BC Hydro's energy resources**

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Generation Resources - Small Hydro



- **South Interior, Bridge, Coastal, & Vancouver Island facilities**
- **1600 MW capacity**
- **7000 GWh average energy**
- **Hourly to seasonal storage**
- **Constrained by flood control, fisheries, recreation, and industrial requirements**
- **Provides 13% of BC Hydro's energy resources**

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Generation Resources - Thermal

- **Burrard Thermal**

- **Single-cycle gas-fired steam turbine**
- **910 MW (6 units) nominal capacity**
- **Now used only for emergency capacity**



- **Island Cogen**

- **Combined-cycle gas-fired turbine**
- **Contract IPP**
- **275 MW capacity**
- **Vancouver Island**



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Generation Resources - IPPs



- **Alcan Long-Term Energy Purchase Agreement**
- **Entitlement Re-purchase Agreements (Arrow Lks Hydro, Brilliant Expansion)**
- **Independent Power Producers**
- **Increasing proportion of BC energy supply**
- **Provided ~ 20% of BC Hydro's energy resources in F2011 (including ICG, Alcan, etc)**

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Co-ordination Agreements

- **Columbia River Treaty**
 - Approximately **\$200M** in annual Downstream Benefits
- **Non-Treaty Storage Agreement**
- **Canal Plant Agreement**
 - Estimated **\$40-50M** in annual Benefits
- **Keenleyside Entitlement Agreement**
- **Alcan Long-Term Purchase Agreement Co-ordination**
- **Skagit Treaty**



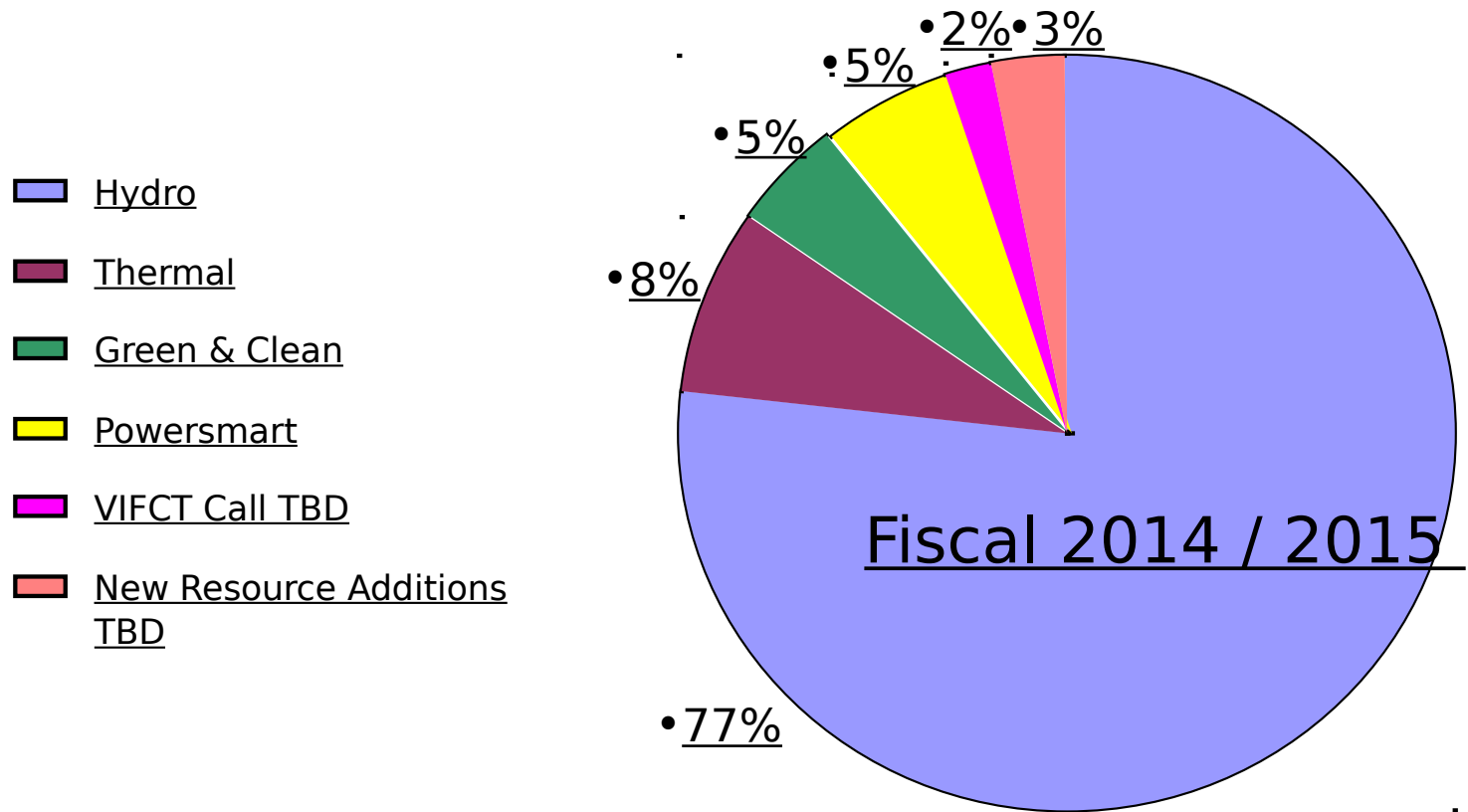
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Generation Resources - Markets

- **BC Hydro, via Powerex, buys and sells energy in liquid markets at 3 regional trading hubs**
 - **US Mid-C (Pacific NW)**
 - **Alberta Power Pool (hourly)**
 - **California Power Pool**
- **Mid-C index price is often used as a contract benchmark**
- **Daily division into two periods: Heavy Load Hours (HLH) and Light Load Hours (LLH) ... with hourly prices in the Alberta Pool.**

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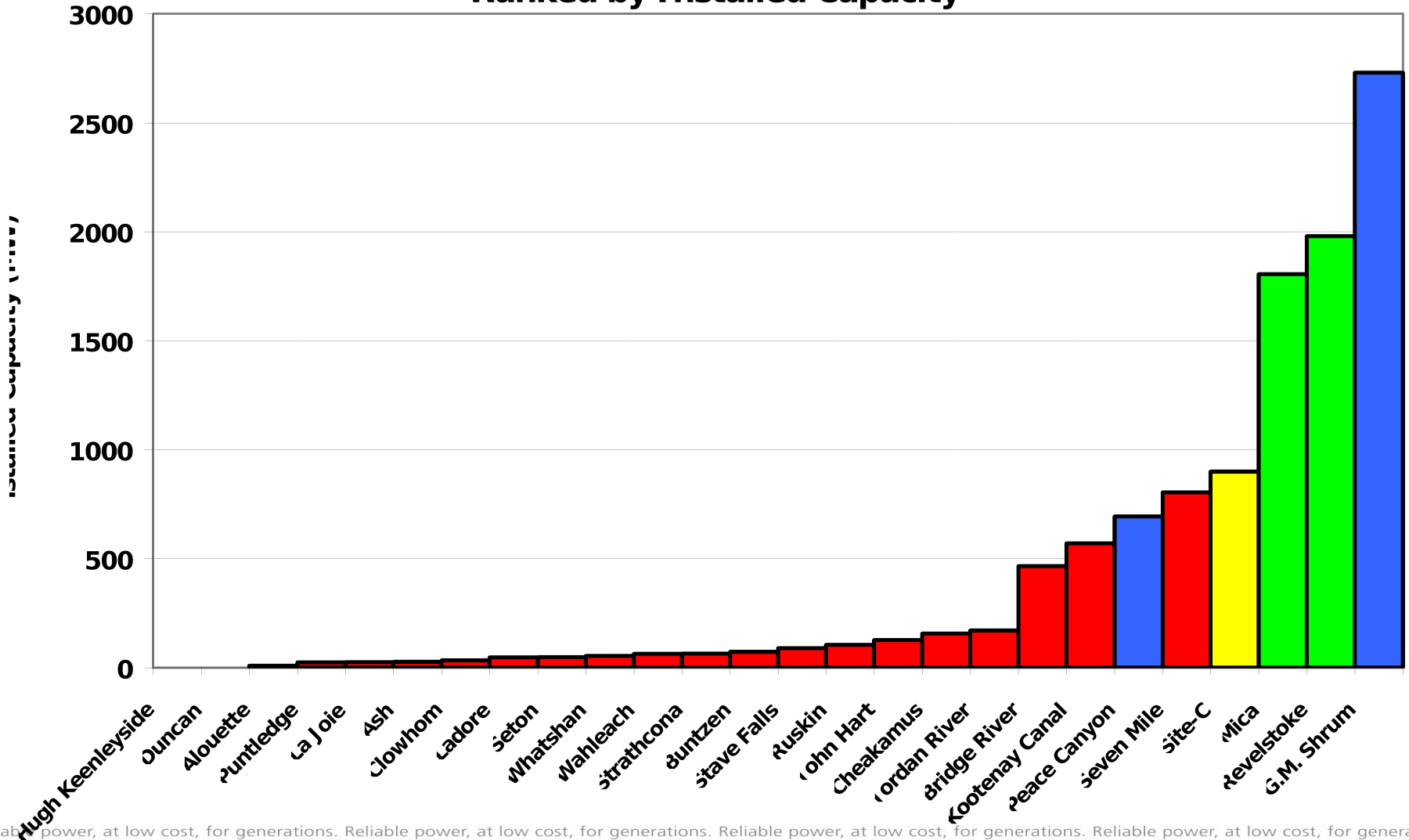
BC Hydro's Resource Mix: Capacity



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BC Hydro Facilities

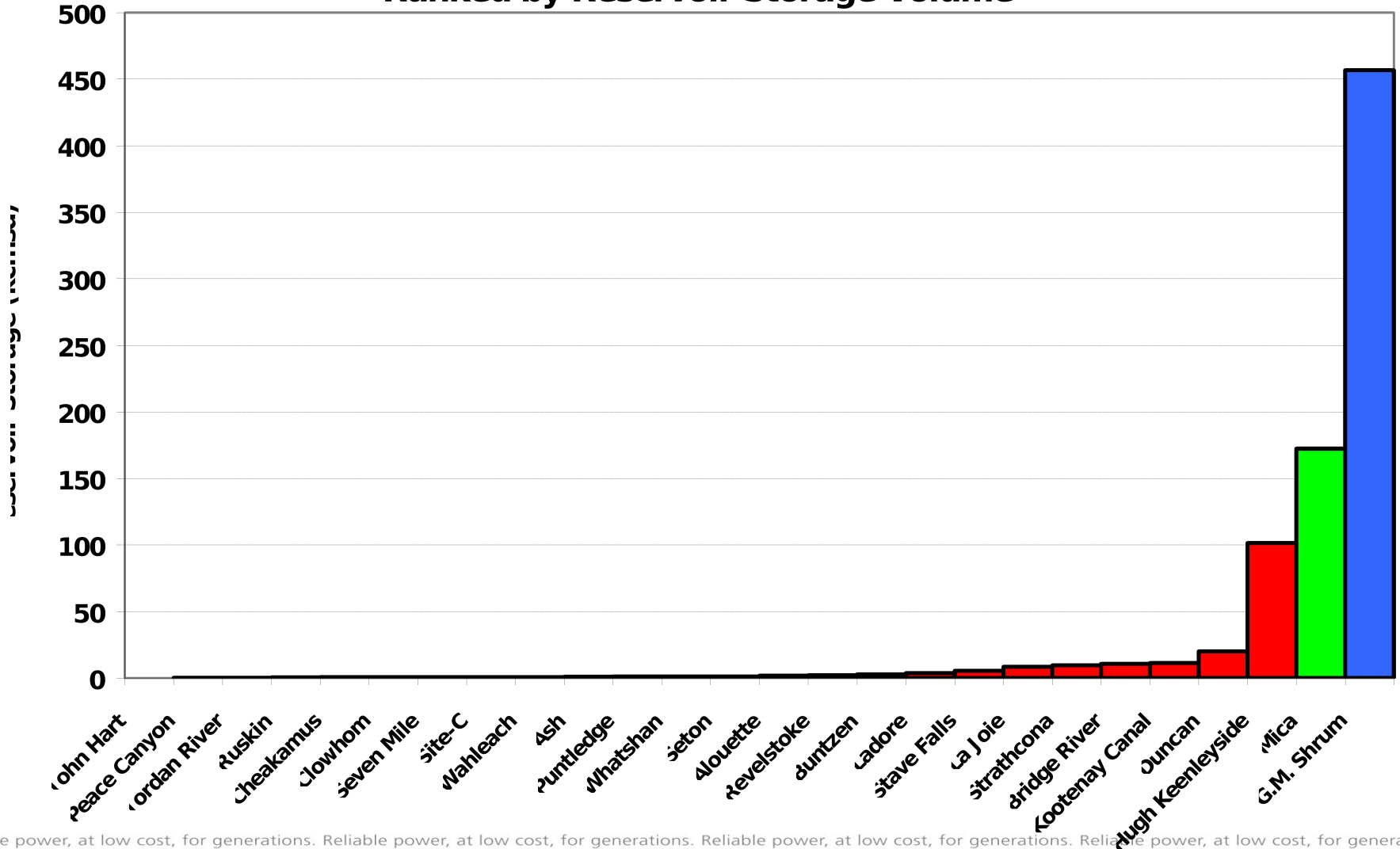
BC Hydro Facilities
Ranked by Installed Capacity



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BC Hydro Facilities

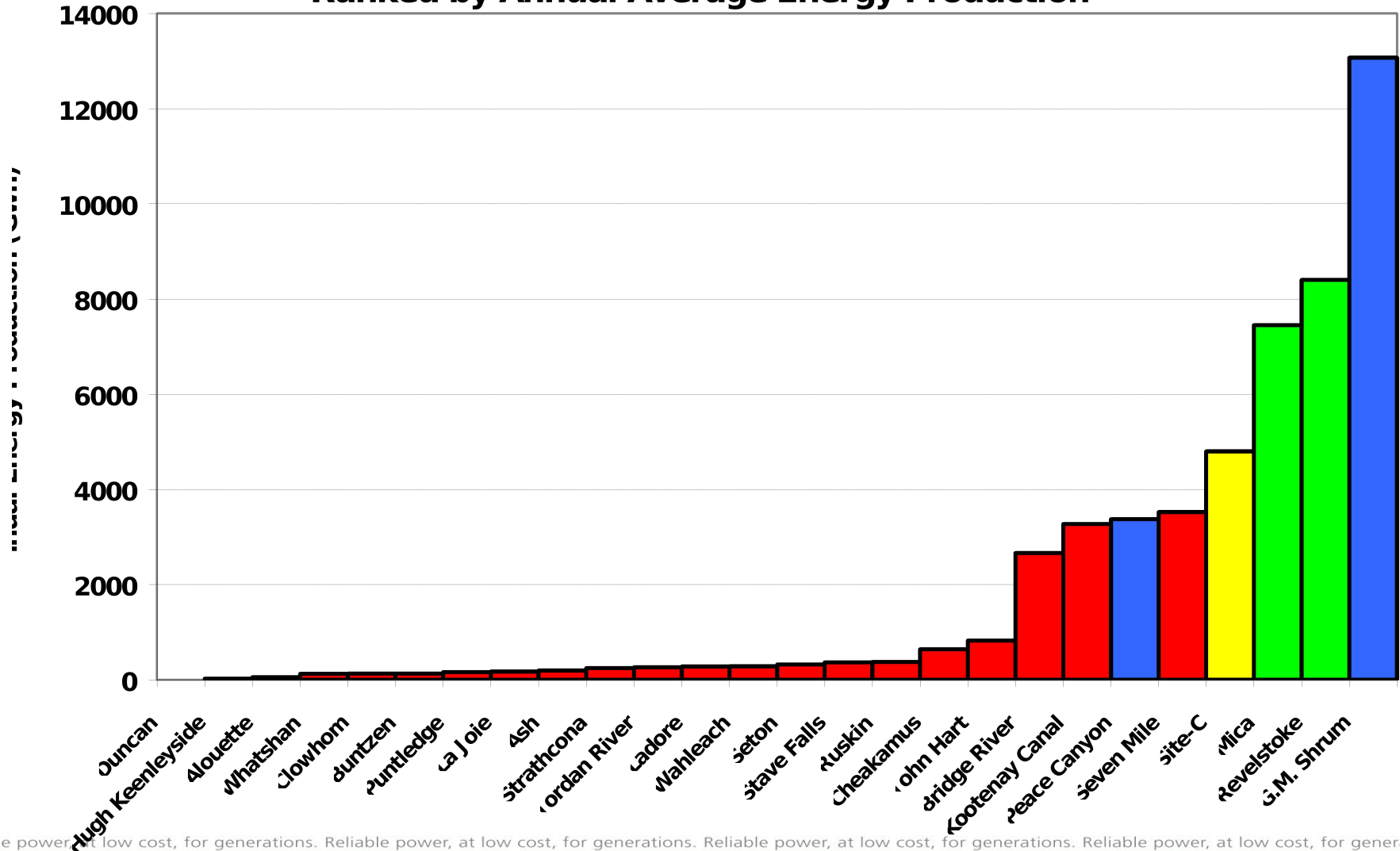
BC Hydro Facilities
Ranked by Reservoir Storage Volume



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BC Hydro Facilities

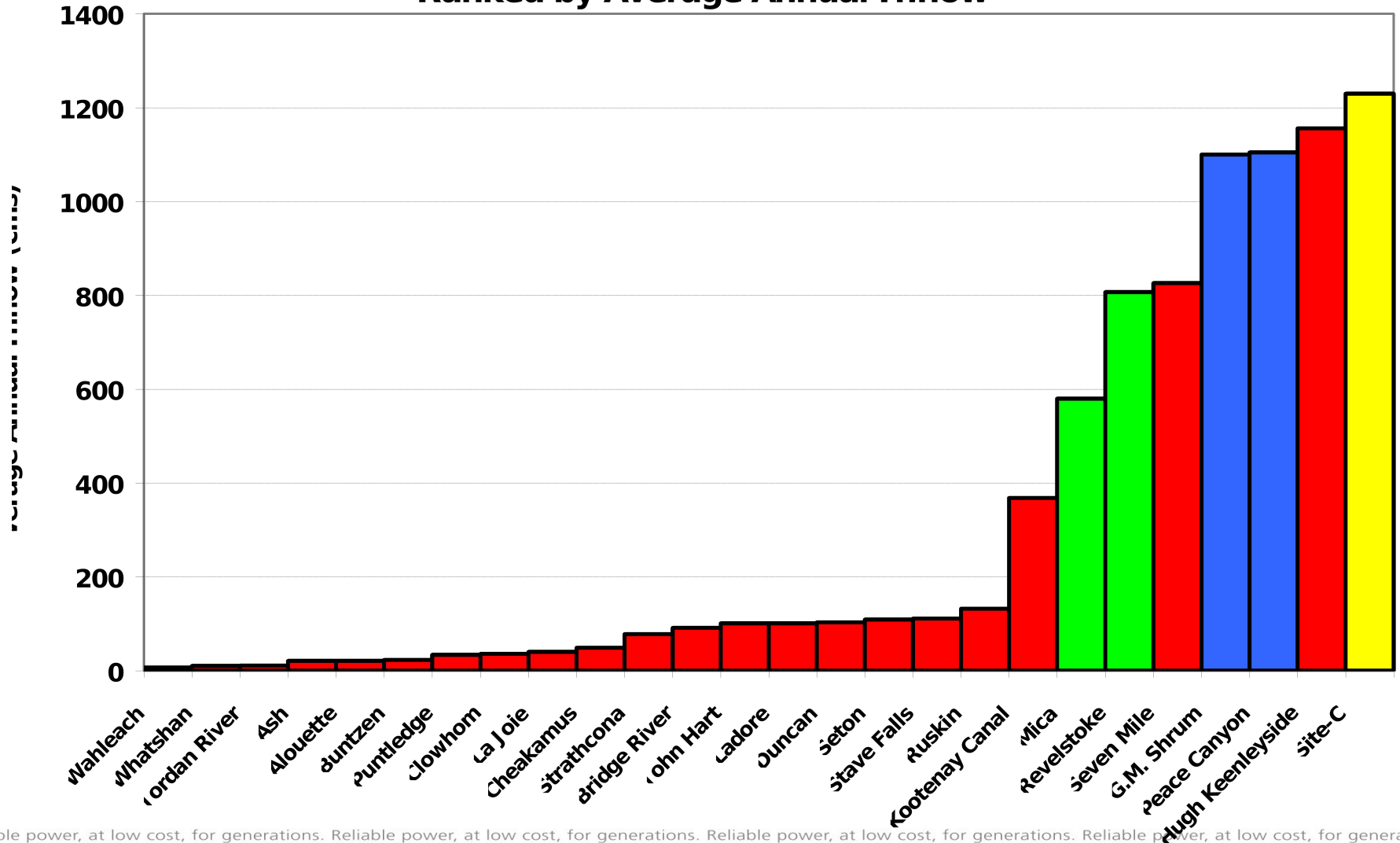
**BC Hydro Facilities
Ranked by Annual Average Energy Production**



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BC Hydro Facilities

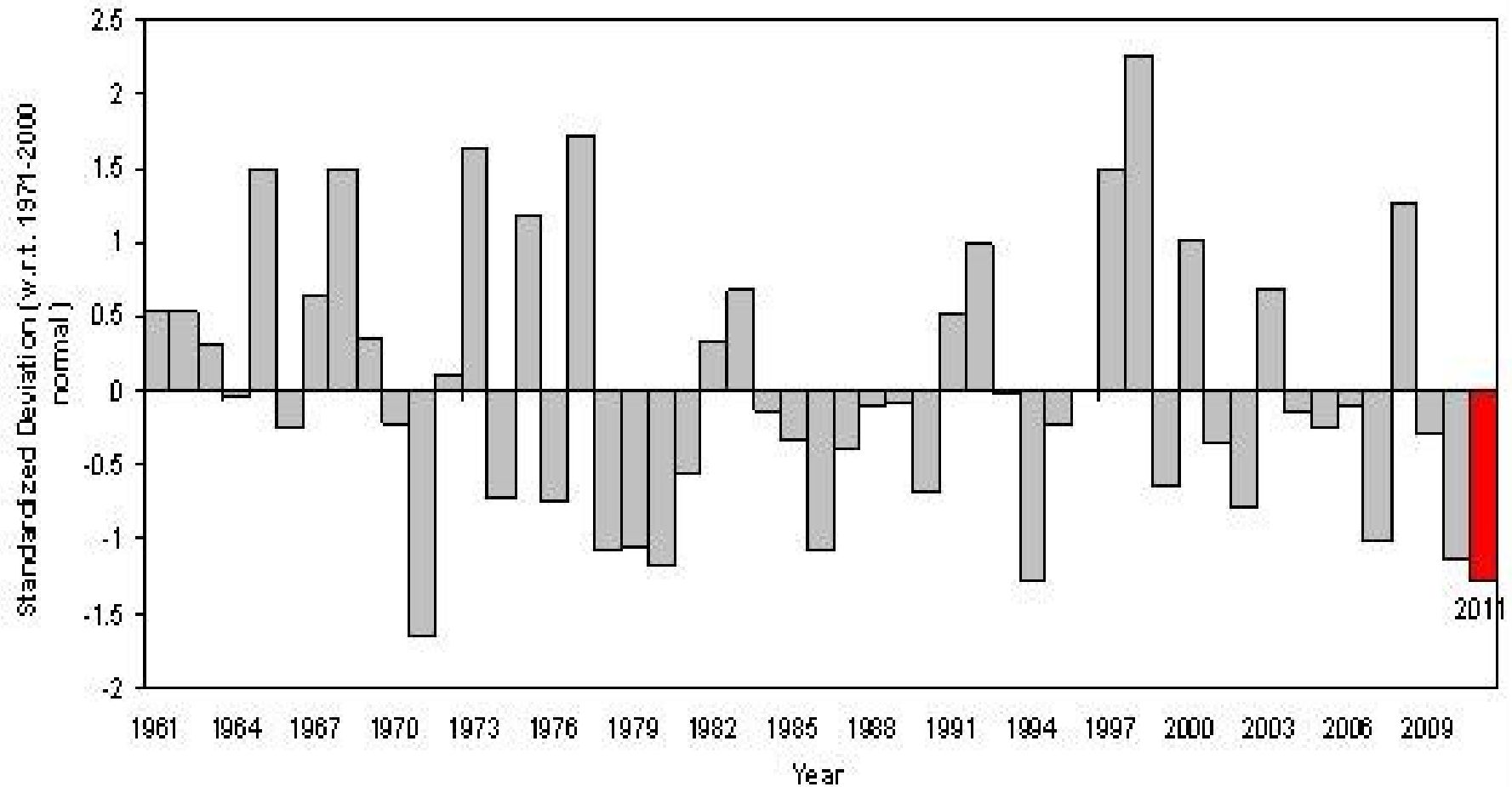
BC Hydro Facilities
Ranked by Average Annual Inflow



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Annual Inflow Volumes Vary

Standardized deviations of the Combined Usable Inflow for 1961-2011 period (FY11 as forecast)



BC Hydro Climate & Streamflow Networks

Remote Climate Station with Snowpillow



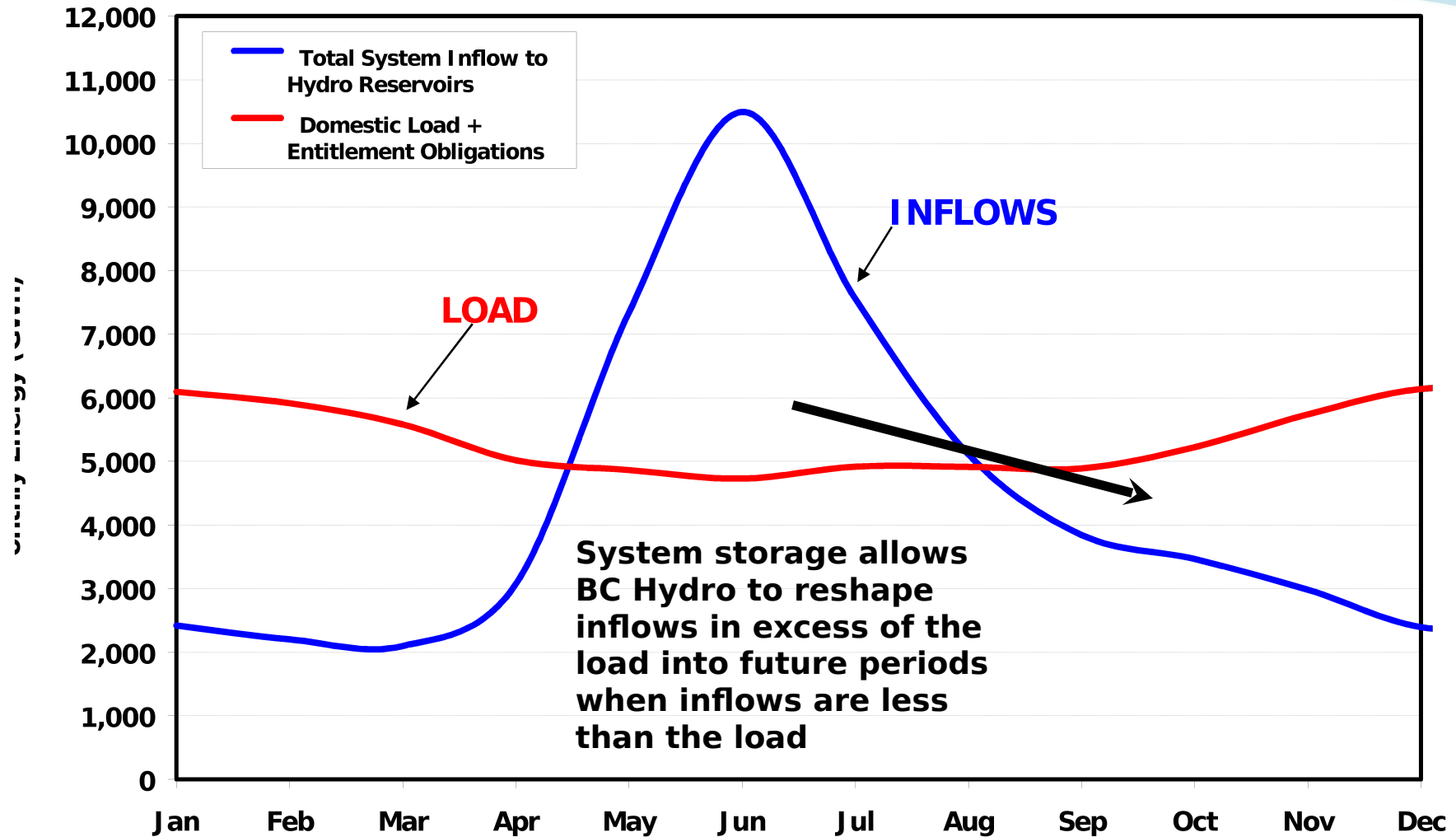
- BC Hydro operates about 150 climate and streamflow stations and 65 snow survey stations
- Annual cost of C\$ 1 million
- Supports runoff forecasting as well as regulatory & environmental compliance checking

Operational Objectives

- “Keeping the lights on” at least cost
- Flood protection
- Maintenance requirements ... can be longer-term issues
- Non-power constraints (may be regulatory & water licence)
 - Minimum fish flow requirements
 - Recreation water-level requirements
 - Heritage site protection
 - Industrial needs
 - Water Use Planning has helped to better define these requirements
- Peace River Ice flow constraints
- Columbia River Treaty constraints
- Possible limits on spending within a fiscal year

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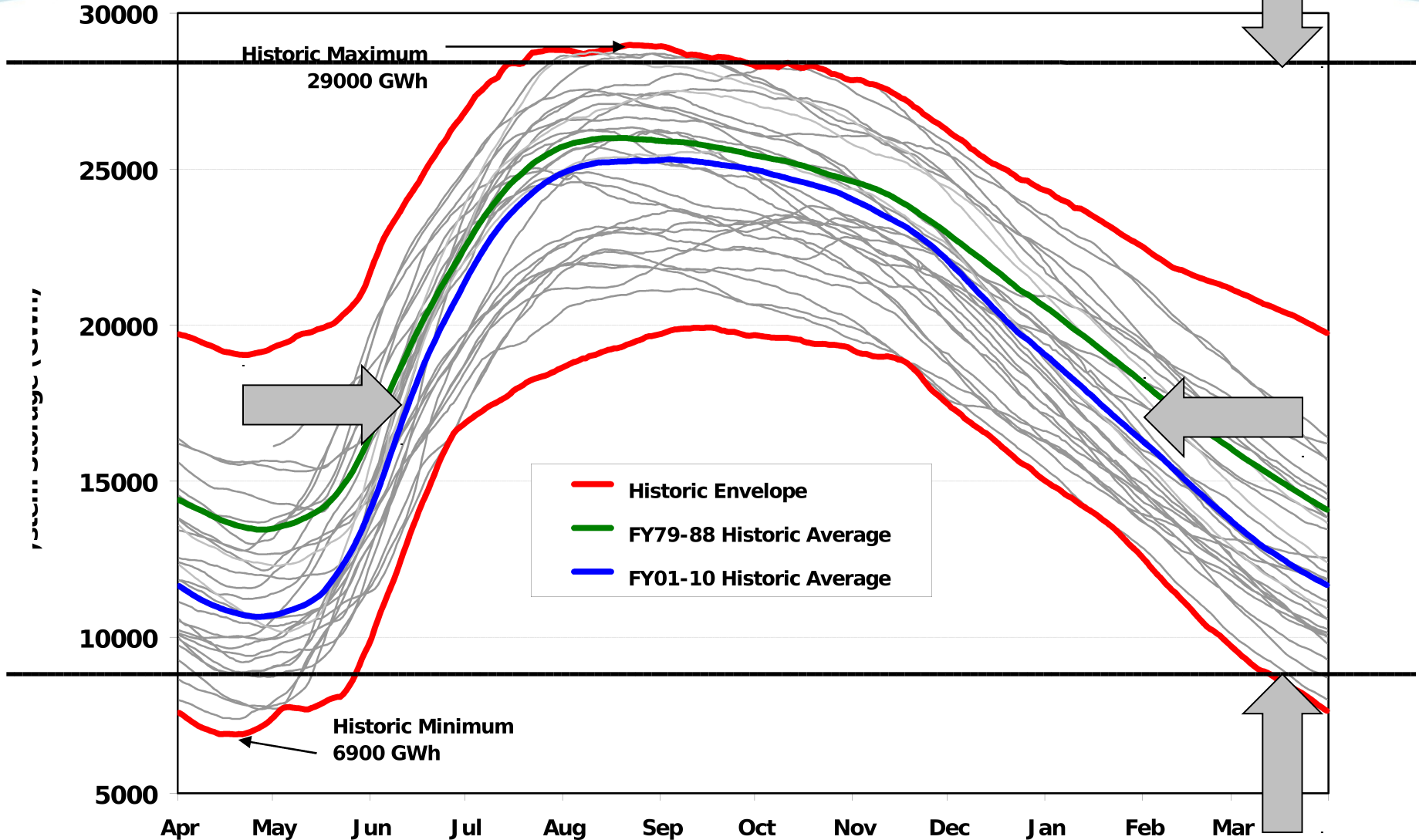
Benefits of System Storage



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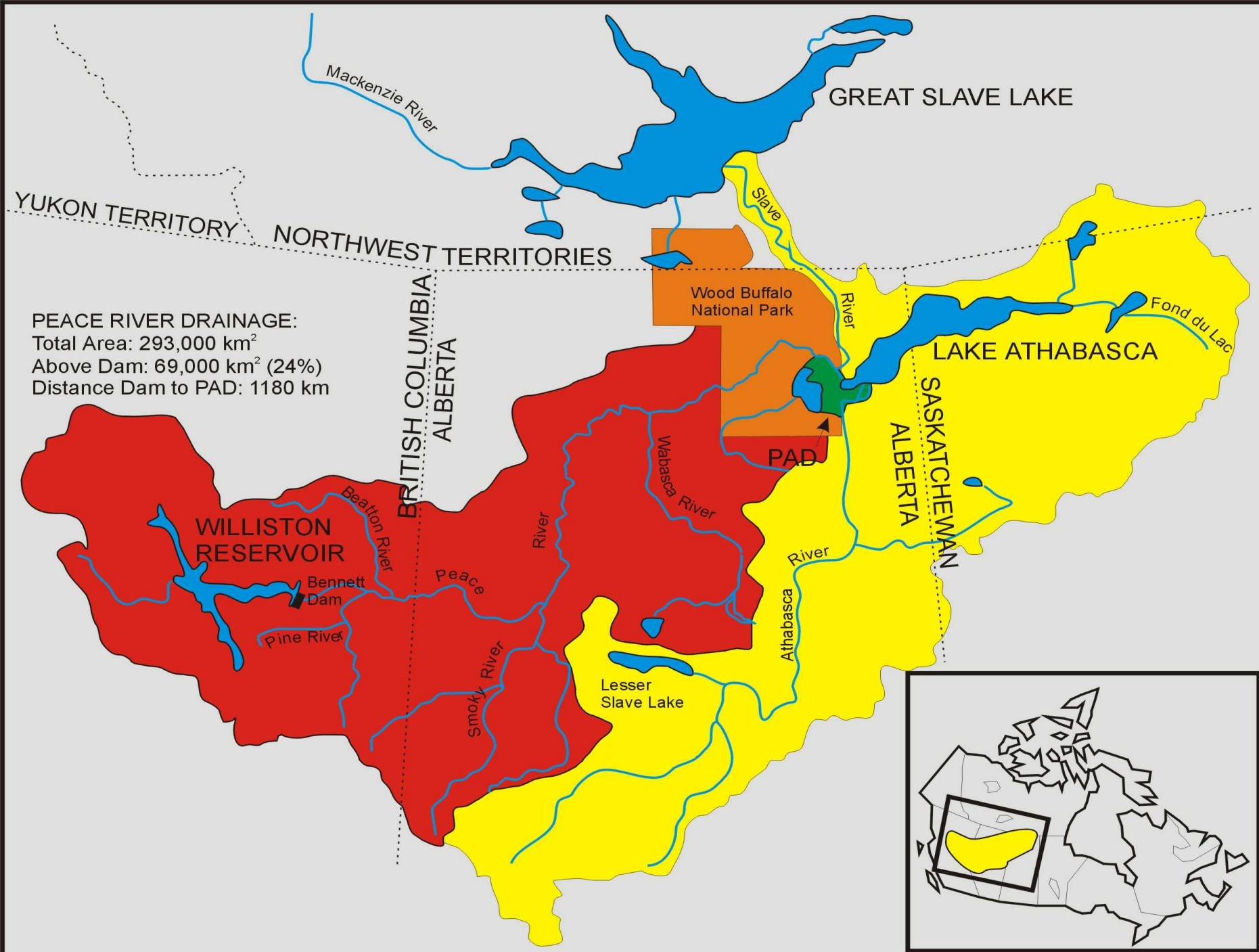
Annual Cycle of System Storage

Historic System Storage Energy Content (Williston + Kinbasket)



Source: Historic System Storage.xls (jdb\data)

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WATER USE PLANNING PROCESS (2000 to 2005)

- **Provincial Direction (1994) to initiate WUP, and address:**
 - Incremental Loss in Operational Flexibility
 - Risk Adverse Constraints by Federal (& Provincial) Fisheries
 - Provincial License Audit
 - NAFTA Challenge
 - Civil Lawsuits
 - Loss of Provincial Control over a Provincial Asset
 - Market Opportunities
- **Water Use Planning engaged public stakeholders, Provincial and Federal agencies, and First Nations in reviewing water management.**
- **The process explored incremental changes to operations to better address economic, social, and environmental interests.**
- **Process based on trade-offs using structured decision making.**
- **Inherent tension between non power or consumptive use vs energy generation.**

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WATER USE PLANNING: SCOPE

- **Structured decision making and trade offs were limited to:**
 - **Dam Safety requirements;**
 - **Incremental operational changes to diversion and flow at the facilities;**
 - **Operational changes based on capabilities of existing facility works;**
 - **Footprint issues (e.g. original dam construction and reservoir formation) were considered outside the scope of Water Use Planning;**
- **Program Scope Limited to an overall \$50 million system cap; and**
- **Individual projects limited to \$ Water Rental Fees paid for that project.**
- **Limits were fundamental in reaching consensus decisions.**

Examples:

WUP Interests & Performance Measures

Fisheries Interests

- Effective Littoral Zone
- Habitat Area
- Spawning Success
- Hydrograph Shape
- Total Gas Pressure
- Thermal Budget
- Fish Entrainment
- Tributary Access
- Fish Stranding
- Cottonwood Recruitment

Hydroelectric Interests

- Value of Energy
- Green House Gases
- Plant Availability

Recreation Interests

- Surfing
- River Recreation Days
- Reservoir Recreation Days
- Log Haul Costs
- Kayak Flows

Social Interests

- Dust Control Measures
- Debris Migration
- Heritage Site Erosion
- Industry Outage Days
- Water Supply Efficacy
- Flood Days
- Mosquito Breeding Success

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WATER USE PLANNING: Process Outcomes

- **WUP engagement for the BC Hydro fleet completed 1998 to 2004:**
 - **~\$20 million information and planning process**
- **Recommendations summarized in a Water Use Plan (WUP).**
- **The WUP contains three components:**
 - **Incremental changes (750+) to diversion and reservoir management;**
 - **Physical works in lieu of an operational changes; and**
 - **Monitoring studies to affirm decisions.**
- **WUP becomes regulatory requirement via *Water Act* Order:**
 - **BC Hydro has received Orders for 22 of 23 WUPs.**